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Lake Owyhee
Malheur County, Oregon

National Eutrophication Survey, Corvallis, Oreg

Prepared for

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U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

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REPORT
ON
LAKE OWYHEE
MALHEUR COUNTY
OREGON
EPA REGION X
WORKING PAPER No. 831

WITH THE COOPERATION OF THE
OREGON DEPARTMENT OF ENVIRONMENTAL QUALITY
AND THE
OREGON NATIONAL GUARD
JANUARY, 1978

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16. ABSTRACT
Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Oregon Department of Environmental Quality for the professional involvement and to the Oregon National Guard for conducting the tributary sampling phase of the the Survey.

William H. Young, Department Director, and Harold L. Sawyer, Administrator, and the staff of the Water Quality Control Division provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

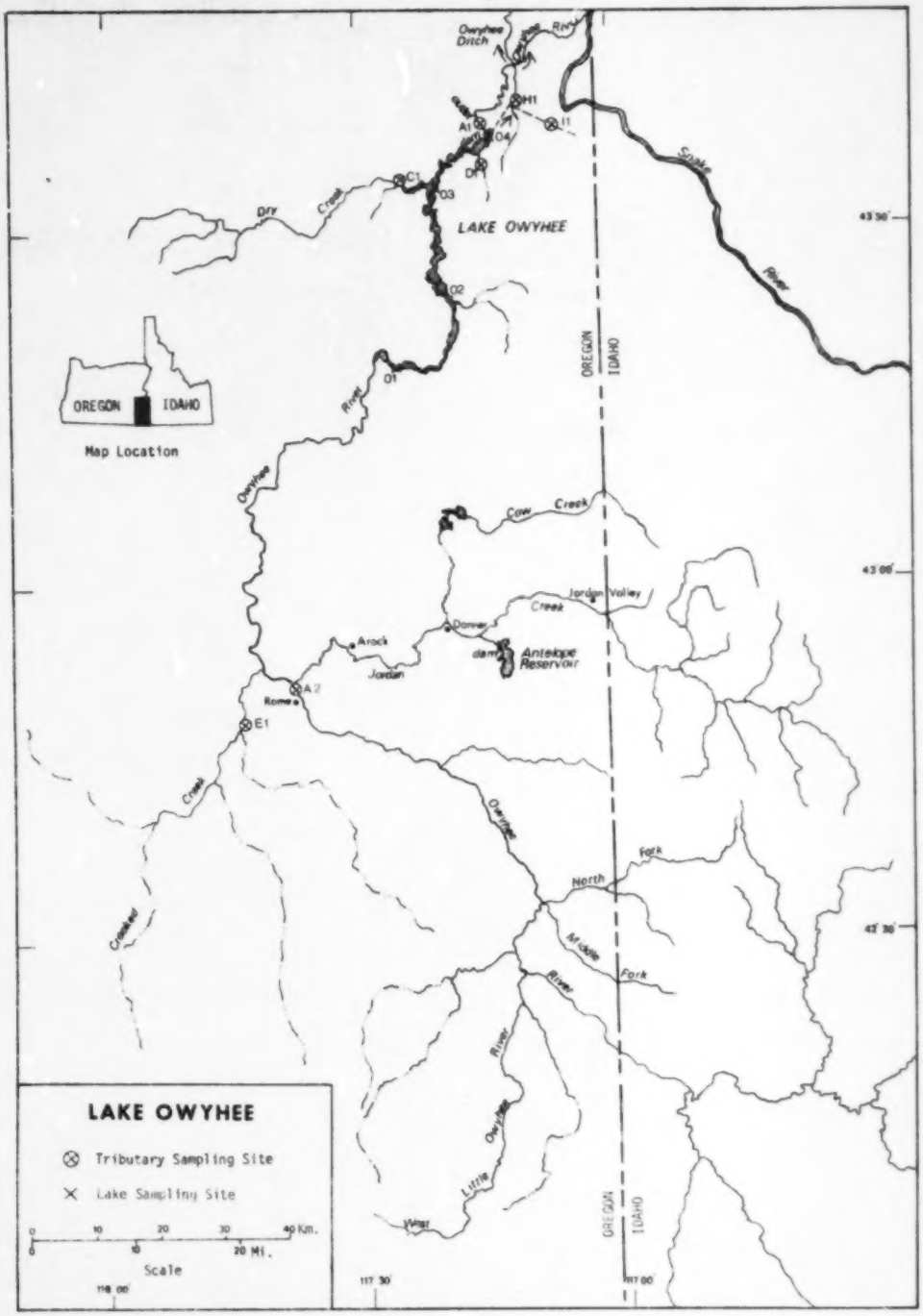
Brigadier General Richard A. Miller, the Adjutant General of Oregon, and Project Officer Lt. Colonel John Mewha, who directed the volunteer efforts of the Oregon National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES and RESERVOIRS

STATE OF OREGON

NAME	COUNTY
Brownlee	Baker, OR; Washington, ID
Diamond	Douglas
Hells Canyon	Baker, Wallowa, OR; Adams, Idaho, ID
Hills Creek	Lane
Owyhee	Malhuer
Oxbow	Baker, OR; Adams, ID
Suttle	Jefferson
Waldo	Lane


Owyhee Ditch
Owyhee River
H1
I1
A1
O4
D1
C1
O3
Dry Creek
LAKE OWYHEE
Snake River
O2
OREGON
IDAHO
O1
OREGON
IDAHO
Map Location
Owyhee River
Cow Creek
Jordan Valley Creek
Antelope Reservoir
Jordan
A2
E1
Creek
Owyhee River
North Fork
Fork
River
Owyhee River
Little
West
43°30'
43°00'
42°30'
117°30'
117°00'
118°00'
LAKE OWYHEE
Tributary Sampling Site
Lake Sampling Site
0 10 20 30 40 Km.
0 10 20 Mi.
Scale

LAKE OWYHEE

STORET NO. 4105

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Lake Owyhee is eutrophic. It ranked last in overall trophic quality among the eight Oregon lakes and reservoirs sampled in 1975 when compared using a combination of six water quality parameters*. All of the other water bodies had less median total phosphorus and median dissolved orthophosphorus, four had less median inorganic nitrogen, two had less mean chlorophyll a, and all of the others had greater mean Secchi disc transparency. Significant depression of dissolved oxygen with depth occurred at station 2 in August and September.

Survey limnologists noted some surface scums of algae in several of the coves and embayments and reported that the water color ranged from a light green to brown.

The low Secchi disc transparencies indicate that at times primary productivity in the lake may be light-limited. In a previous report, it is stated that sediment is a major surface runoff problem in the drainage basin (Volk, 1974).

B. Rate-Limiting Nutrient:

The algal assay results indicate Lake Owyhee was limited by nitrogen at the time the sample was collected (04/08/75).

* See Appendix A.

The lake data indicate nitrogen limitation at all sampling times and stations.

C. Nutrient Controllability:

1. Point sources--No known wastewater treatment plants discharged in the watershed during the sampling year. Septic tanks serving lakeshore residences and campgrounds were estimated to have contributed less than 0.1% of the total phosphorus load to Lake Owyhee. However, a shoreline survey would have to be done to determine actual input from such sources.

The present phosphorus loading of 1.77 g/m^2/year is 2.4 times that proposed by Vollenweider (Vollenweider and Dillon, 1974) as a eutrophic loading (see page 11). Any significant improvement of the present trophic condition would involve control of nutrient runoff from non-point sources.

2. Non-point sources--Non-point sources accounted for 99.9% of the total phosphorus load during the sampling year. The Owyhee River contributed 93.0%, and the minor tributaries and immediate drainage contributed an estimated 6.0%.

An additional investigation is needed to determine controllability of nutrients from non-point sources. Initiation of land-conservation methods within the drainage basin may result in a reduced sediment and nutrient load.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS†

A. Morphometry††:

1. Surface area: 56.25 kilometers^2.
2. Mean depth: 24.6 meters.
3. Maximum depth: 35.7 meters.
4. Voluem: 1,381.509 x 10^6 m^3.
5. Mean hydraulic retention time: 1.7 years (based on outflow).

B. Tributary and Outlet:
(see Appendix C for flow data)

1. Tributaries -

Name	Drainage area (km^2)*	Mean flow (m^3/sec)*
Owyhee River	20,720.0	25.520
Minor tributaries & immediate drainage -	8,182.1	1.660
Totals	28,848.1	27.180

2. Outlets -

Owyhee River	28,904.4	8.776
Canal H-1	-	11.587
Canal I-1	-	5.676
Totals	28,904.4**	26.039

C. Precipitation***:

1. Year of sampling: 28.2 centimeters.
2. Mean annual: 22.3 centimeters.

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† Table of metric equivalents--Appendix B.
†† McHugh, 1972.
* For limits of accuracy, see Working Paper No. 175, "...Survey Methods, 1973-1976".
** Includes area of lake.
*** See Working Paper No. 175.

III. WATER QUALITY SUMMARY

Lake Owyhee was sampled three times during the open-water season of 1975 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from one or more depths at four stations on the lake (see map, page v). During each visit, a single depth-integrated (4.6 m or near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the April visit, a single 18.9-liter depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 4.6 meters at station 1, 27.4 meters at station 2, 59.4 meters at station 3, and 65.5 meters at station 4.

The sampling results are presented in full in Appendix D and are summarized in the following table.

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR OWYHEE
STORET CODE 4105

PARAMETER	1ST SAMPLING (4/ 8/75) 4 SITES RANGE	MEAN	MEDIAN	2ND SAMPLING (8/ 1/75) 4 SITES RANGE	MEAN	MEDIAN	3RD SAMPLING (9/16/75) 4 SITES RANGE	MEAN	MEDIAN
TEMP (C)	3.6 - 6.0	4.7	4.5	1.4 - 21.2	12.3	13.1	1.1 - 19.2	12.9	17.6
DISS OXY (MG/L)	10.6 - 12.2	11.5	11.6	3.4 - 9.8	6.9	7.2	1.8 - 10.0	6.7	7.0
CNDCTVY (MCROMO)	113. - 154.	138.	142.	124. - 328.	194.	192.	104. - 304.	186.	155.
PH (STAND UNITS)	7.7 - 8.0	7.9	7.9	7.6 - 9.4	8.5	8.3	7.4 - 8.7	8.0	7.8
TOT ALK (MG/L)	63. - 92.	81.	86.	51. - 142.	83.	81.	56. - 124.	84.	82.
TOT P (MG/L)	0.088 - 0.133	0.103	0.098	0.060 - 0.161	0.098	0.095	0.050 - 0.143	0.086	0.081
ORTHO P (MG/L)	0.064 - 0.103	0.081	0.077	0.016 - 0.069	0.047	0.053	0.024 - 0.076	0.050	0.056
NO2+NO3 (MG/L)	0.280 - 0.420	0.380	0.390	0.030 - 0.480	0.242	0.290	0.020 - 0.420	0.236	0.250
AMMONIA (MG/L)	0.040 - 0.080	0.050	0.050	0.040 - 0.270	0.076	0.050	0.020 - 0.050	0.026	0.020
KJEL N (MG/L)	0.400 - 0.800	0.454	0.400	0.200 - 0.800	0.412	0.400	0.200 - 0.600	0.422	0.400
INORG N (MG/L)	0.340 - 0.500	0.436	0.430	0.070 - 0.600	0.318	0.420	0.040 - 0.470	0.262	0.280
TOTAL N (MG/L)	0.770 - 1.100	0.834	0.795	0.430 - 0.880	0.654	0.680	0.420 - 0.890	0.657	0.720
CHLRPYL A (UG/L)	0.8 - 3.0	1.4	0.9	2.6 - 9.7	5.9	5.6	1.8 - 4.3	2.8	2.5
SECCHI (METERS)	0.3 - 0.3	0.3	0.3	0.3 - 0.7	0.5	0.6	0.3 - 0.9	0.6	0.7

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
04/08/75	1. Cyclotella sp.	207
	2. Chroomonas (?) sp.	207
	3. Chlamydomonas sp.	69
	4. Phormidium sp.	69
	5. Cryptomonas sp.	34
	Other genera	68
	Total	654
08/01/75	1. Coelosphaerium sp.	304
	2. Cryptomonas sp.	154
	3. Aphanizomenon sp.	101
	4. Phormidium sp.	101
	5. Scenedesmus sp.	51
	Total	711
09/16/75	1. Aphanizomenon sp.	409
	2. Chroomonas (?) sp.	204
	Total	613

2. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (µg/l)
04/08/75	1	3.0
	2	0.9
	3	0.8
	4	0.9
08/01/75	1	2.6
	2	7.5
	3	9.7
	4	3.7
09/16/75	1	4.3
	2	1.8
	3	1.8
	4	3.2

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.040	0.304	8.2
0.050 P	0.090	0.304	8.5
0.050 P + 1.0 N	0.090	1.304	15.8
1.0 N	0.040	1.304	10.1

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential primary productivity of Lake Owyhee was high at the time the sample was collected (04/08/75). Also, the lack of growth response with the addition of phosphorus until nitrogen was also added indicates the lake was nitrogen limited at that time. Note that the addition of nitrogen alone resulted in a significantly greater yield than that of the control.

The lake data indicate nitrogen limitation as well. The mean inorganic nitrogen/orthophosphorus ratios were 8/1 or less at all sampling stations and times, and nitrogen limitation would be expected.

IV. NUTRIENT LOADINGS
(See Appendix E for data)

For the determination of nutrient loadings, the Oregon National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v), except for the high runoff months of January and February when two samples were collected. Sampling was begun in October, 1974, and was completed in September, 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Oregon District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were calculated using mean annual concentrations and mean annual flows. Nutrient loads for outlet canal (I-1) were calculated using the mean concentrations in the Owyhee River at station A-1 and the mean annual flow at I-1.

Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the mean concentrations in the Owyhee River at station A-2 and the mean annual ZZ flow.

No known wastewater treatment plants impacted the lake during the sampling year.

A. Waste Sources:

1. Known municipal - None

2. Known industrial - None

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/ yr	% of total
a. Tributaries (non-point load) -		
Owyhee River	92,550	93.0
b. Minor tributaries & immediate drainage (non-point load) -	6,020	6.0
c. Known municipal STP's - None	-	-
d. Septic tanks* -	30	<0.1
e. Known industrial - None	-	-
f. Direct precipitation** -	985	1.0
Total	99,585	100.0

2. Outputs -

Lake outlets -	Owyhee River	28,505
	Outlet Canal (H-1)	54,080
	Outlet Canal (I-1)	18,435
	Total	101,020

3. Net annual P loss - 1,435 kg.

* Estimate based on 1 park, 1 resort, 4 campgrounds, and 60 lakeshore residences; see Working Paper No. 175.
** See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/yr	% of total
a. Tributaries (non-point load) -		
Owyhee River	974,610	88.6
b. Minor tributaries & immediate drainage (non-point load) -	63,395	5.8
c. Known municipal STP's - None	-	-
d. Septic tanks* -	1,065	0.1
e. Known industrial - None	-	-
f. Direct precipitation** -	60,730	5.5
Total	1,099,800	100.0

2. Outputs -

Lake outlets -	Owyhee River	299,455
	Outlet Canal (H-1)	524,725
	Outlet Canal (I-1)	193,675
	Total	1,017,855

3. Net annual N accumulation - 81,945 kg.

D. Non-point Nutrient Export by Subdrainage Area:

Tributary	kg P/km²/yr	kg N/km²/yr
Owyhee River	4	47

E. Mean Nutrient Concentrations in Ungaged Streams:

Tributary	Mean Total P Conc. (mg/l)	Mean Total N Conc. (mg/l)
Dry Creek	0.086	0.870
Birch Creek	0.102	1.241
Crooked Creek	0.047	1.372

* Estimate based on 1 park, 1 resort, 4 campgrounds, and 60 lakeshore residences; see Working Paper No. 175.
** See Working Paper No. 175.

F. Yearly Loads:

In the following table, the existing phosphorus loadings are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" loading is one at which the receiving water would become eutrophic or remain eutrophic; his "permissible" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic loading would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with short hydraulic retention times.

	Total Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
grams/m^2/yr	1.77	loss*	19.6	1.5

Vollenweider phosphorus loadings ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Lake Owyhee:	
"Dangerous" (eutrophic loading)	0.74
"Permissible" (oligotrophic loading)	0.37

* There was an apparent loss of phosphorus during the sampling year. This may have been due to unknown point sources discharging directly to the lake, resolubilization of previously sedimented phosphorus, or underestimation of the phosphorus load in Owyhee River due to the sampling location (station A-2; see map page v) which is a considerable distance from the lake.

V. LITERATURE REVIEWED

McHugh, Robert A., 1972. Interim study of some physical, chemical, and biological properties of selected Oregon lakes. OR Dept. of Environ. Qual., Portland.

Volk, V. Van, 1974. Water quality in eastern Oregon. In: Land and Water Use in Oregon. Seminar conducted by OSU Water Res. Research Inst., Corvallis, pp 113-130.

Vollenweider, R. A., and P. J. Dillon, 1974. The application of the phosphorus loading concept to eutrophication research. Natl. Res. Council of Canada Publ. No. 13690, Canada Centre for Inland Waters, Burlington, Ontario.

VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P
4101	BROWNLEE RESERVOIR	0.079	0.560	428.133	16.207	14.500	0.043
4102	DIAMOND LAKE	0.028	0.040	294.500	7.300	6.800	0.011
4103	HELLS CANYON RESERVOIR	0.068	0.640	429.111	18.722	12.400	0.045
4104	HILLS CREEK RESERVOIR	0.038	0.060	435.200	2.333	7.400	0.027
4105	OWYHEE	0.095	0.425	480.417	3.350	13.200	0.064
4106	OXBOW RESERVOIR	0.071	0.690	425.555	10.311	12.200	0.040
4107	SUTTLE LAKE	0.031	0.040	95.000	9.167	6.800	0.020
4108	WALDO LAKE	0.005	0.040	-100.000	0.350	6.800	0.006

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P	INDEX NO
4101	BROWNLEE RESERVOIR	14 (1)	29 (2)	43 (3)	14 (1)	0 (0)	29 (2)	129
4102	DIAMOND LAKE	86 (6)	93 (6)	71 (5)	57 (4)	86 (5)	86 (6)	479
4103	HELLS CANYON RESERVOIR	43 (3)	14 (1)	29 (2)	0 (0)	29 (2)	14 (1)	129
4104	HILLS CREEK RESERVOIR	57 (4)	57 (4)	14 (1)	86 (6)	57 (4)	57 (4)	328
4105	OWYHEE	0 (0)	43 (3)	0 (0)	71 (5)	14 (1)	0 (0)	128
4106	OXBOW RESERVOIR	29 (2)	0 (0)	57 (4)	29 (2)	43 (3)	43 (3)	201
4107	SUTTLE LAKE	71 (5)	71 (5)	86 (6)	43 (3)	86 (5)	71 (5)	428
4108	WALDO LAKE	100 (7)	93 (6)	100 (7)	100 (7)	86 (5)	100 (7)	579

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	4108	WALDO LAKE	579
2	4102	DIAMOND LAKE	479
3	4107	SUTTLE LAKE	428
4	4104	HILLS CREEK RESERVOIR	328
5	4106	OXBOW RESERVOIR	201
6	4101	BROWNLEE RESERVOIR	129
7	4103	HELLS CANYON RESERVOIR	129
8	4105	OWYHEE	128

APPENDIX B

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR OREGON 08/11/76

LAKE CODE 4105 LAKE OWYHEE

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 28904.4

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
4105A1	2890.4	9.996	17.188	27.269	28.289	10.251	3.738	3.426	2.775	2.237	0.765	0.085	0.085	8.776
4105A2	20720.0	23.87	33.98	52.67	86.93	48.70	25.26	6.77	3.79	3.54	4.16	5.66	12.32	25.52
4105M1	0.0	0.0	0.0	0.085	11.582	26.590	25.797	27.751	25.259	16.141	4.955	0.0	0.0	11.587
4105I1	0.0	0.0	0.0	0.113	7.476	12.459	11.723	12.969	11.667	8.665	2.662	0.0	0.0	5.676
4105ZZ	8194.4	1.36	1.30	1.98	3.40	2.04	1.42	1.42	1.36	1.36	1.36	1.47	1.47	1.66

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 28904.4
SUM OF SUB-DRAINAGE AREAS = 28904.4
TOTAL FLOW IN = 533.49
TOTAL FLOW OUT = 106.10

NOTE *** M1 & I1 ARE CANAL OUTFLOWS & NO DR. AREA. T. OUTFLOW ARE DAM & 3 CANALS.

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
4105A1	10	74	0.793	19	0.082				
	11	74	0.071	17	0.071				
	12	74	0.068	14	0.068				
	1	75	0.068	2	0.065	12	0.068	26	0.071
	2	75	0.076	9	0.074	23	0.076		
	3	75	3.511	9	0.096				
	4	75	109.869	19	117.515				
	5	75	139.303	23	165.087				
	6	75	36.529	14	81.269				
	7	75	5.635	17	5.097				
	8	75	5.125	16	5.324				
	9	75	3.738	12	4.049				
4105A2	10	74	3.993	20	3.993				
	11	74	5.324	16	4.842				
	12	74	6.116	15	6.513				
	1	75	6.258	11	6.626	25	7.306		
	2	75	15.008	9	8.608	23	8.269		
	3	75	84.384	8	81.553				
	4	75	104.772	19	92.879				
	5	75	190.856	24	146.398				
	6	75	77.305	10	90.048				
	7	75	18.463	17	18.831				
	8	75	6.994	11	5.748				
	9	75	5.437	12	5.182				

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TRIBUTARY FLOW INFORMATION FOR OREGON 08/11/76

LAKE CODE 4105 LAKE OWYHEE

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
410541	10	74	6.116	20	0.0				
	11	74	0.0	17	0.0				
	12	74	0.0	15	0.0				
	1	75	0.0	12	0.0	26	0.0		
	2	75	0.0	9	0.0	23	0.0		
	3	75	0.0	9	0.0				
	4	75	3.964	20	3.879				
	5	75	23.475	23	29.733				
	6	75	26.590	14	29.166				
	7	75	29.450	18	29.733				
	8	75	26.136	13	28.317				
	9	75	21.238	16	21.181				
410511	10	74	3.171	20	0.0				
	11	74	0.0	17	0.0				
	12	74	0.0	15	0.0				
	1	75	0.0	12	0.0	26	0.0		
	2	75	0.0	9	0.0	23	0.0		
	3	75	0.0	9	0.0				
	4	75	2.619	20	3.370				
	5	75	11.978	23	14.215				
	6	75	13.309	14	14.243				
	7	75	14.357	18	14.555				
	8	75	12.686	13	14.158				
	9	75	11.044	16	11.638				

APPENDIX D

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 76/08/12

410501
43 18 21.0 117 25 13.0 3
OWYHEE
41045 OREGON

130791

11EPALES 2111202
0018 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/04/08	14 30	0000	6.0	11.6	12	113	7.95	63	0.060	0.700	0.280	0.089
	14 30	0005	5.9	11.6		114	7.90	65	0.050	0.800	0.300	0.077
	14 30	0012	5.1	11.6		113	8.00	67	0.060	0.600	0.300	0.091
75/08/01	15 50	0000	20.6	6.0	13	319	8.55	140	0.090	0.500	0.060	0.053
	15 50	0005	20.4	7.4		304	8.60	136	0.080	0.500	0.060	0.050
	15 50	0015	20.0	4.0		328	8.30	142	0.130	0.600	0.080	0.069
75/09/16	11 15	0000	9.4	8.4	12	302	8.70	95	0.020K	0.400	0.040	0.028
	11 15	0005	8.1	6.0		304	8.50	121	0.020	0.400	0.070	0.040
	11 15	0015	8.4	5.8		304	8.50	124	0.020	0.400	0.070	0.039

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/04/08	14 30	0000	0.118	3.0	
	14 30	0005	0.116		
	14 30	0012	0.101		
75/08/01	15 50	0000	0.097	2.6	
	15 50	0005	0.099		
	15 50	0015	0.150		
75/09/16	11 15	0000	0.057	4.3	
	11 15	0005	0.081		
	11 15	0015	0.081		

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/08/12

410502
43 24 35.0 117 19 47.0 3
OWYHEE
41045 OREGON
130791

11EPALES 2111202
0085 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/04/08	15 00	0000	5.4	12.0	12	117	7.85	68	0.050	0.700	0.370	0.097
	15 00	0005	5.4	10.8		118	7.75	67	0.060	0.500	0.370	0.103
	15 00	0015	5.3	11.0		119	7.70	66	0.060	0.400	0.370	0.097
	15 00	0025	5.2	11.0		120	7.85	67	0.050	0.400	0.380	0.091
	15 00	0050	5.1	10.8		137	7.80	76	0.060	0.400	0.410	0.097
	15 00	0080	5.0	10.6		143	7.70	76	0.080	0.400	0.420	0.081
75/08/01	15 15	0000	21.2	7.8	27	218	9.30	99	0.050	0.800	0.040	0.017
	15 15	0005	19.6	6.4		225	9.20	99	0.050	0.500	0.050	0.017
	15 15	0015	19.5	5.5		205	8.30	92	0.170	0.400	0.290	0.065
	15 15	0035	13.1	4.4		203	8.00	92	0.060	0.300	0.310	0.068
	15 15	0060	7.5	4.0		163	7.80	67	0.090	0.400	0.480	0.066
	15 15	0090	4.4	3.4		201	7.60	77	0.120	0.400	0.480	0.053
75/09/16	10 45	0000	19.2	6.6	36	223	8.30	79	0.020	0.400	0.070	0.035
	10 45	0005	18.9	7.2		219	8.70	93	0.020	0.400	0.020	0.024
	10 45	0015	18.7	3.4		230	7.80	115	0.030	0.400	0.250	0.067
	10 45	0035	16.6	1.8		268	7.45	78	0.030	0.200	0.400	0.074
	10 45	0068	8.0	3.0		135	8.35	74	0.050	0.300	0.420	0.056

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/04/08	15 00	0000	0.119	0.9	
	15 00	0005	0.118		
	15 00	0015	0.116		
	15 00	0025	0.112		
	15 00	0050	0.116		
	15 00	0080	0.124		
75/08/01	15 15	0000	0.078	7.5	
	15 15	0005	0.060		
	15 15	0015	0.107		
	15 15	0035	0.106		
	15 15	0060	0.140		
	15 15	0090	0.161		
75/09/16	10 45	0000	0.060	1.8	
	10 45	0005	0.050		
	10 45	0015	0.095		
	10 45	0035	0.120		
	10 45	0068	0.143		

STORET RETRIEVAL DATE 76/08/12

410503
43 33 55.0 117 20 44.0 3
OWYHEE
41045 OREGON

130791

11EPALES 2111202
0200 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/04/08	15 30	0000	4.6	12.0	12	151	8.00	83	0.040	0.400	0.400	0.081
	15 30	0005	4.4	11.6		149	8.00	81	0.050	0.500	0.400	0.065
	15 30	0015	4.4	11.8		149	8.00	88	0.040	0.400	0.410	0.069
	15 30	0025	4.4	11.6		149	8.00	88	0.040	0.400	0.390	0.076
	15 30	0050	4.3	12.0		150	8.00	89	0.040	0.400	0.390	0.074
	15 30	0100	4.3	12.0		150	8.00	92	0.040	0.400	0.400	0.077
	15 30	0150	4.2	11.6		150	8.00	89	0.040	0.400	0.390	0.078
	15 30	0195	4.2	11.4		154	8.00	91	0.060	0.400	0.400	0.090
75/08/01	14 35	0000	20.1	8.6	22	156	9.30	65	0.050	0.500	0.050	0.028
	14 35	0005	18.7	7.8		155	9.30	65	0.040	0.500	0.030	0.025
	14 35	0015	18.4	7.0		156	9.15	64	0.050	0.400	0.030	0.026
	14 35	0035	13.1	6.0		162	8.10	63	0.070	0.400	0.390	0.065
	14 35	0065	6.2	7.2		160	7.90	64	0.070	0.400	0.380	0.055
	14 35	0100	2.6	8.6		224	7.90	85	0.050	0.200	0.440	0.057
	14 35	0135	1.7	8.8		217	7.90	88	0.050	0.300	0.440	0.063
	14 35	0175	1.4	8.8		154	9.40	83	0.270	0.400	0.290	0.044
75/09/16	10 15	0000	18.3	9.4	30	194	8.50	64	0.040	0.500	0.040	0.026
	10 15	0005	18.5	6.2		190	8.35	82	0.020	0.500	0.050	0.029
	10 15	0015	18.4	4.4		184	7.65	74	0.030	0.600	0.200	0.060
	10 15	0040	15.4	3.0		155	7.45	72	0.020K	0.500	0.390	0.076
	10 15	0070	6.0	6.8		104	7.50	80	0.030	0.400	0.400	0.072
	10 15	0115	3.5	7.6		141	7.50	84	0.020	0.400	0.410	0.068
	10 15	0160	3.0	8.0		149	7.50	83	0.020K	0.400	0.410	0.068

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/08/12

410503
43 33 55.0 117 20 44.0 3
OWYHEE
41045 OREGON
130791

11EPALES 2111202
0200 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/04/08	15 30	0000	0.097	0.8	
	15 30	0005	0.093		
	15 30	0015	0.095		
	15 30	0025	0.098		
	15 30	0050	0.100		
	15 30	0100	0.096		
	15 30	0150	0.098		
	15 30	0195	0.133		
75/08/01	14 35	0000	0.084	9.7	
	14 35	0005	0.079		
	14 35	0015	0.079		
	14 35	0035	0.119		
	14 35	0065	0.109		
	14 35	0100	0.097		
	14 35	0135	0.095		
	14 35	0175	0.088		
75/09/16	10 15	0000	0.079	1.8	
	10 15	0005	0.062		
	10 15	0015	0.122		
	10 15	0040	0.119		
	10 15	0070	0.096		
	10 15	0115	0.095		
	10 15	0160	0.096		

STORET RETRIEVAL DATE 76/06/12

410504
43 38 25.0 117 14 02.0 3
OWYHEE
41045 OREGON
130791

11EPALES 2111202
0999 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/04/08	16	10 0000	4.6	12.2	12	142	8.00	85	0.040	0.400	0.380	0.077
	16	10 0005	4.5	11.6		142	8.00	85	0.040	0.400	0.380	0.070
	16	10 0015	4.5	11.8		142	7.95	86	0.060	0.400	0.390	0.076
	16	10 0025	4.5	11.8		142	7.95	90	0.040	0.400	0.390	0.075
	16	10 0050	4.5	11.6		142	7.95	90	0.040	0.400	0.390	0.083
	16	10 0100	4.3	11.6		142	7.95	89	0.050	0.400	0.390	0.064
	16	10 0125	4.3	11.4		142	7.90	89	0.040	0.400	0.390	0.075
	16	10 0150	3.9	11.2		143	7.90	87	0.060	0.400	0.390	0.075
	16	10 0215	3.6	11.2		150	7.90	90	0.040	0.400	0.400	0.076
75/08/01	14	00 0000	18.6	7.2	23	145	9.20	58	0.050	0.400	0.040	0.016
	14	00 0005	18.3	7.8		139	9.30	60	0.050	0.400	0.040	0.017
	14	00 0015	18.3	6.4		133	8.95	59	0.050	0.400	0.040	0.020
	14	00 0040	12.4	6.0		124	8.20	51	0.090	0.400	0.390	0.067
	14	00 0070	5.8	8.4		149	8.00	63	0.040	0.300	0.380	0.062
	14	00 0100	3.1	7.2		192	8.00	81	0.050	0.300	0.430	0.060
	14	00 0135	2.0	9.8		203	8.10	84	0.040	0.300	0.420	0.055
	14	00 0175	1.4	9.0		207	8.30	86	0.040	0.300	0.410	0.050
75/09/16	09	40 0000	17.8	7.8	24	160	8.00	110	0.020	0.500	0.230	0.027
	09	40 0005	17.9			155	8.65	61	0.040	0.500	0.030	0.026
	09	40 0015	17.6	8.0		147	8.40	59	0.040	0.500	0.020K	0.032
	09	40 0040	15.8	6.2		138	7.80	56	0.020K	0.400	0.340	0.064
	09	40 0080	4.0	9.0		135	7.80	81	0.020K	0.400	0.390	0.058
	09	40 0120	2.2	10.0		142	7.70	84	0.020K	0.400	0.390	0.059
	09	40 0160	1.5	9.4		143	7.70	85	0.020K	0.400	0.390	0.057
	09	40 0210	1.1	9.0		146	7.70	87	0.030	0.400	0.390	0.056

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/08/12

410504
43 38 25.0 117 14 02.0 3
OWYHEE
41045 OREGON
130791

11EPALES 2111202
0999 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/04/08	16	10 0000	0.094	0.9	
	16	10 0005	0.090		
	16	10 0015	0.088		
	16	10 0025	0.090		
	16	10 0050	0.096		
	16	10 0100	0.090		
	16	10 0125	0.089		
	16	10 0150	0.088		
	16	10 0215	0.099		
75/08/01	14	00 0000	0.070	3.7	
	14	00 0005	0.076		
	14	00 0015	0.069		
	14	00 0040	0.118		
	14	00 0070	0.096		
	14	00 0100	0.093		
	14	00 0135	0.091		
	14	00 0175	0.087		
75/09/16	09	40 0000	0.077	3.2	
	09	40 0005	0.068		
	09	40 0015	0.064		
	09	40 0040	0.099		
	09	40 0080	0.077		
	09	40 0120	0.075		
	09	40 0160	0.075		
	09	40 0210	0.089		

APPENDIX E

TRIBUTARY DATA

STORET RETRIEVAL DATE 76/08/12

4105A1
43 39 17.0 117 15 16.0 4
OWYHEE RIVER
41 7.5 OWYHEE DAM
O/LAKE OWYHEE
SEC RD BRDG .8 MI DWNSTRM FRM OWYHEE DAM
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/10/20	12 07		0.112	0.700	0.035	0.070	0.095
74/11/17	11 00		0.144	0.600	0.070	0.040	0.080
74/12/14	11 30		0.280	0.900	0.020	0.040	0.050
75/01/02	14 10		0.320	1.200	0.030	0.055	0.080
75/01/26	13 25		0.152	0.600	0.032	0.048	0.070
75/02/09	11 45		0.050	0.900	0.024	0.032	0.080
75/02/23	12 15		0.016	0.400	0.008	0.016	0.040
75/04/19	11 45		0.367	0.762	0.040	0.060	0.080
75/05/23	20 15		0.360	0.850	0.030	0.065	0.100
75/06/14	10 50		0.360	1.050	0.025	0.065	0.080
75/07/17	20 30		0.330	0.500	0.010	0.055	0.080
75/08/16	18 00		0.340	1.900	0.575	0.080	0.390
75/09/12	21 10		0.370	0.590	0.027	0.045	0.110

STORET RETRIEVAL DATE 76/08/12

4105A2
42 53 45.0 107 39 00.0 4
OWYHEE RIVER
41 MALHEUR CO MAP
T/LAKE OWYHEE 090291
SEC RD BRDG 2 MI NW OF ROME
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/10/20	13 00		0.200	0.200	0.015	0.015	0.040
74/11/16	12 20		0.232	1.400	0.045	0.010	0.020
74/12/15	13 24		0.352	0.600	0.020	0.015	0.020
75/01/11	12 45		0.528	0.600	0.010	0.015	0.040
75/01/25	13 00		0.504	0.400	0.040	0.016	0.020
75/02/09	12 42		0.416	0.600	0.112	0.024	0.050
75/02/23	12 30		0.392	0.700	0.024	0.064	0.110
75/03/08	14 30		0.267	1.150	0.080	0.072	0.180
75/04/19	13 00		0.160	0.950	0.055	0.070	0.140
75/05/24	11 30		0.400	1.050	0.080	0.082	0.240
75/06/10	07 25		0.200	1.450	0.030	0.080	0.210
75/07/17	22 15		0.170	0.700	0.025	0.110	0.170
75/08/11	20 00		0.090	0.500	0.025	0.100	0.270
75/09/18	10 00		0.145	2.600	0.045	0.035	0.100

STORET RETRIEVAL DATE 76/08/12

410SC1
43 34 10.0 117 24 20.0 4
DRY CREEK
41 7.5 TWIN SPRINGS
T/LAKE OWYHEE 130791
BNK 1.9 MI E OF DEAD HORSE SPRING
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
75/01/12	11	30	0.048	0.600	0.005		0.025
75/01/26	10	15	0.096	0.800	0.080	0.080	0.100
75/02/09	12	00	0.022	0.900	0.024	0.084	0.120
75/02/23	11	00	0.075	0.800	0.144	0.072	0.080
75/04/20	10	30	0.015	1.300	0.050	0.130	0.190
75/05/23	18	30	0.030	1.100	0.055	0.050	0.080
75/06/14	09	30	0.005	0.300	0.010	0.010	0.010

STORET RETRIEVAL DATE 76/08/12

410501
43 36 25.0 117 15 13.0 4
BIRCH CREEK
41 7.5 THE ELBOW
T/LAKE OWYHEE 130791
UNMPRVD RD BRDG .3 MI SE OF RESORT
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
75/01/26	13 00		1.500	0.900	0.072	0.200	0.210
75/02/09	11 22		0.080	0.700	0.048	0.040	0.050
75/02/23	12 33		0.244	0.800	0.024	0.064	0.070
75/04/20	12 15		0.080	0.550	0.040		0.070
75/05/23	21 45		0.300	1.050	0.035	0.070	0.110

STORET RETRIEVAL DATE 76/08/12

4105E1
42 51 30.0 117 44 00.0 4
CROOKED CREEK
41 MALHEUR CO MAP
T/LAKE OWYHEE 130791
ST HWY 95 BRDG 7 MI SW OF ROME
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/10/19	13 50		0.760	0.300	0.025	0.020	0.025
74/11/16	12 00		0.780	0.500	0.040	0.020	0.030
74/12/15	13 00		0.800	0.500	0.010	0.025	0.040
75/01/11	12 20		0.800	0.300	0.020	0.025	0.040
75/01/25	12 35		0.780	0.400	0.016	0.024	0.030
75/02/08	12 20		0.736	0.300	0.072	0.024	0.024
75/02/23	12 20		0.750	0.700	0.016	0.016	0.050
75/03/08			0.627	1.150	0.024	0.040	0.060
75/04/19	13 15		0.650	1.000	0.040	0.020	0.040
75/05/24	12 40		0.400	0.700	0.020		0.080
75/06/10	08 30		0.430	1.130	0.020	0.030	0.035
75/07/17	22 30		0.630	1.150	0.020	0.020	0.040
75/08/11	20 30		0.040	0.820	0.045	0.040	0.061
75/09/18	10 30		0.280	1.800	0.030	0.050	0.110

STORET RETRIEVAL DATE 76/08/12

4105H1
43 41 30.0 117 11 15.0 4
NORTH CANAL
41 7.5 OWYHEE DAM
O/LAKE OWYHEE 130791
BRDG .3 MI N OF JCT WITH TUNNEL#1 AND #5
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
75/04/20	13 30		0.360	0.800	0.030	0.065	0.080
75/05/23	22 15		0.375	1.400	0.030		0.100
75/06/14	13 00		0.310	0.500	0.020	0.070	0.100
75/07/18	21 30		0.270	0.900	0.020	0.080	0.100
75/08/13	20 50		0.370	1.100	0.060	0.085	0.390
75/09/16	17 00		0.230	2.000	0.035	0.050	0.120

STORET RETRIEVAL DATE 76/08/12

41051F
43 30 00.0 117 07 15.0 4
SUCCOR CREEK
41 MALHEUR CO MAP
T/LAKE OWYHEE 130791
BNK AT SUCCOR CRK ST PRK 12 M N ROCKVIL
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/10/19	16 05		0.016	0.900	0.030	0.030	0.070
74/11/16	15 00		0.016	1.400	0.035	0.010	0.020
74/12/15	16 30		0.040	3.100	0.030	0.080	0.140
75/01/08	15 30		0.312	1.000	0.056	0.110	0.150
75/01/11	15 30		0.280	0.500	0.010	0.100	0.140
75/01/25	15 50		0.264	0.900	0.032	0.112	0.130
75/02/22	15 25		0.432	0.700	0.032	0.160	0.240
75/03/08	11 55		0.300	1.150	0.024	0.196	0.840
75/04/19	15 30		0.220	0.750	0.190	0.145	0.240
75/05/21	15 00		0.260	0.900	0.020	0.135	0.500
75/06/10	18 30		0.030	0.950	0.040	0.150	0.190
75/07/17	19 45		0.010	0.750	0.020	0.150	0.160
75/08/11	17 30		0.040	0.900	0.017	0.032	0.055
75/09/18	17 30		0.165	1.400	0.030	0.035	0.110